

1

The table below gives information about four alcohols.

Alcohol	Formula	Melting point in °C	Boiling point in °C
Methanol	CH ₃ OH	-94	65
Ethanol	CH ₃ CH ₂ OH	-118	78
Propanol	CH ₃ CH ₂ CH ₂ OH	-129	97
Butanol	CH ₃ CH ₂ CH ₂ CH ₂ OH	-89	118

(a) Which alcohol in the table is liquid over the greatest temperature range?

.....

(1)

(b) Which statement is correct?

Tick **one** box.

A molecule of ethanol has 5 hydrogen atoms

Butanol has the highest boiling point

Methanol has the largest molecules

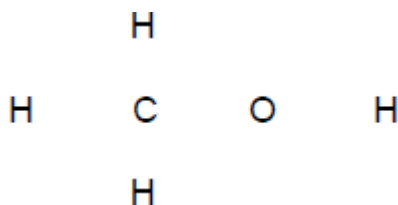
Propanol has the highest melting point

(1)

(c) A molecule of methanol has five single covalent bonds.

Draw the missing bonds in **Figure 1** to complete the displayed formula for methanol.

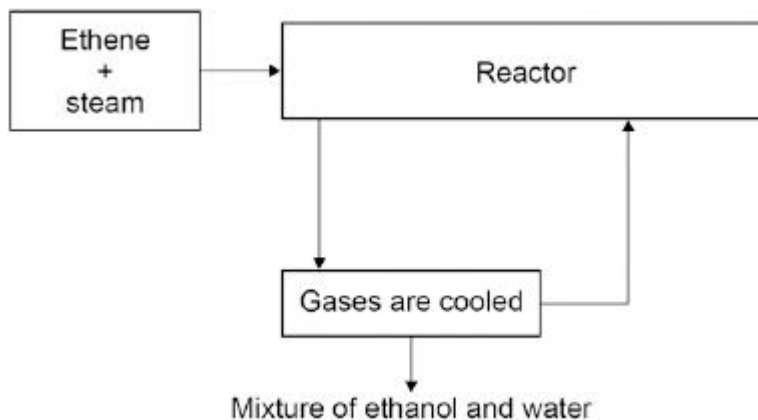
Figure 1



(1)

(d) **Figure 2** shows a flow diagram of the process to produce ethanol.

Figure 2



Complete the word equation for the reaction to produce ethanol.

..... + → ethanol

(1)

(e) What happens to the unreacted ethene?

.....

(1)

(f) Wine contains ethanol.
 A bottle of wine was left open in air.
 After a few days, the wine tasted of vinegar.
 Vinegar is a solution of ethanoic acid in water.

Explain how oxidation causes the wine to taste of vinegar after a few days.

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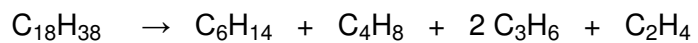
(3)
 (Total 8 marks)

2

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon, $C_{18}H_{38}$



(a) Which product of the reaction shown is an alkane?

Tick **one** box.



(1)

- (b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

	Boiling point	Flammability	Viscosity
A	highest	lowest	highest
B	highest	lowest	lowest
C	lowest	highest	highest
D	lowest	highest	lowest

Which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{18}H_{38}$ compare with the properties of C_2H_4 , C_3H_6 , C_4H_8 and C_6H_{14} ?

Tick **one** box.

A

B

C

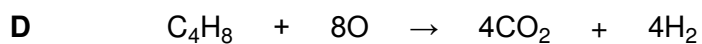
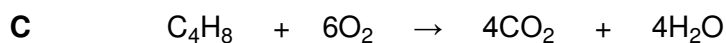
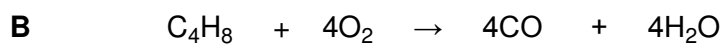
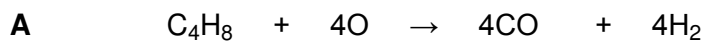
D

(1)

(c) The hydrocarbon C_4H_8 was burnt in air.

Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?



Tick **one** box.

A

B

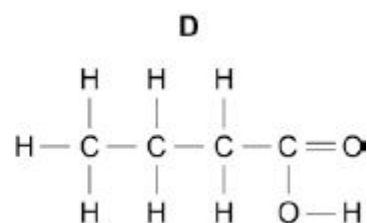
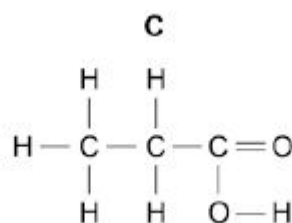
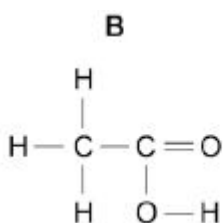
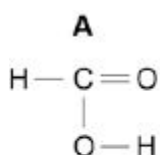
C

D

(1)

(d) Propanoic acid is a carboxylic acid.

Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?



Tick **one** box.

A

B

C

D

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound?

Tick **one** box.

Propane

Propene

Propanol

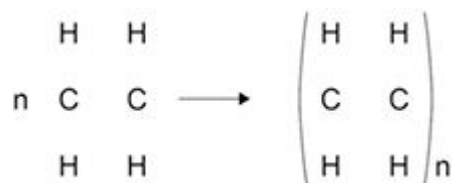
Polyester

(1)
(Total 5 marks)

3

Ethene is used to produce poly(ethene).

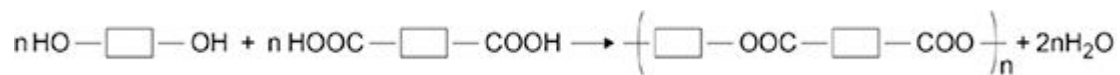
(a) Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.



(2)

- (b) Polyesters are made by a different method of polymerisation.

The equation for the reaction to produce a polyester can be represented as:



Compare the polymerisation reaction used to produce poly(ethene) with the polymerisation reaction used to produce a polyester.

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(4)
(Total 6 marks)

4

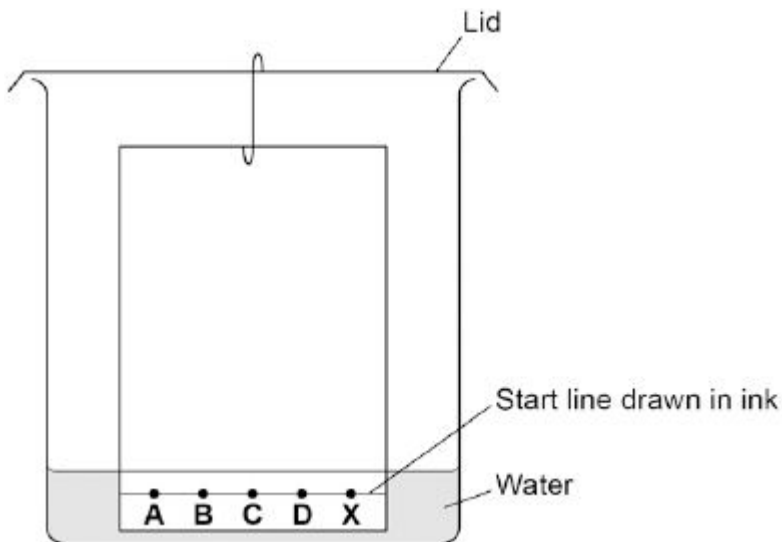
A student investigated food dyes using paper chromatography.

This is the method used.

1. Put a spot of food colouring **X** on the start line.
2. Put spots of four separate dyes, **A**, **B**, **C** and **D**, on the start line.
3. Place the bottom of the paper in water and leave it for several minutes.

Figure 1 shows the apparatus the student used.

Figure 1



- (a) Write down **two** mistakes the student made in setting up the experiment and explain what problems one of the mistakes would cause.

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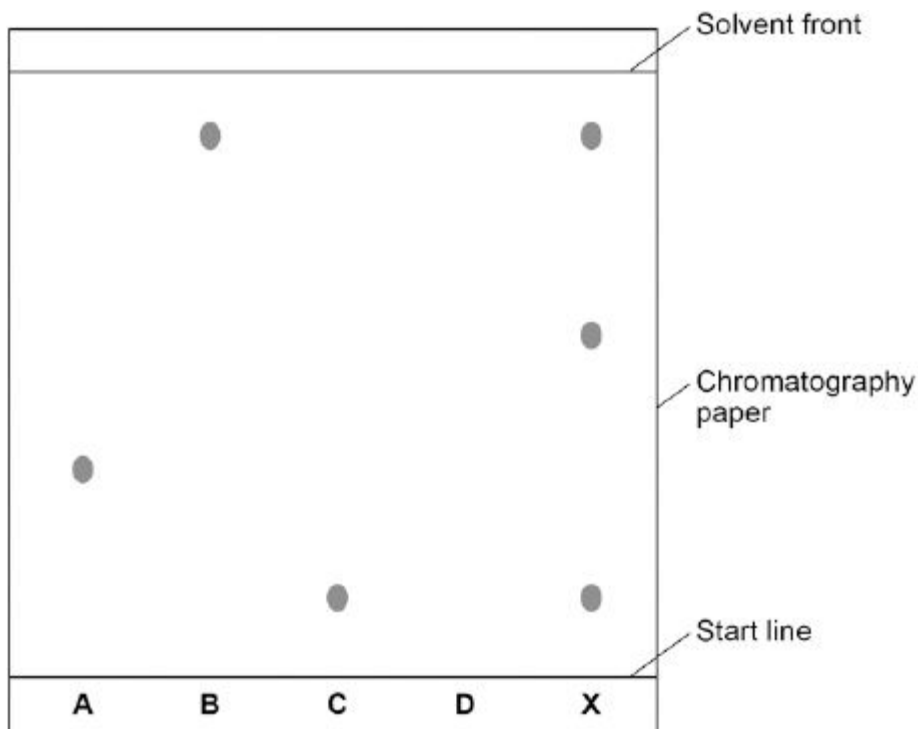
.....

(2)

- (b) Another student set up the apparatus correctly.

Figure 2 shows the student's results. The result for dye **D** is not shown.

Figure 2



Calculate the R_f value of dye **A**

Give your answer to two significant figures.

.....

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.....

.....

R_f value =

(3)

- (c) Dye **D** has an R_f value of 0.80. Calculate the distance that dye **D** moved on the chromatography paper.

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Distance moved by dye **D** =

(1)

(d) Explain how the different dyes in **X** are separated by paper chromatography.

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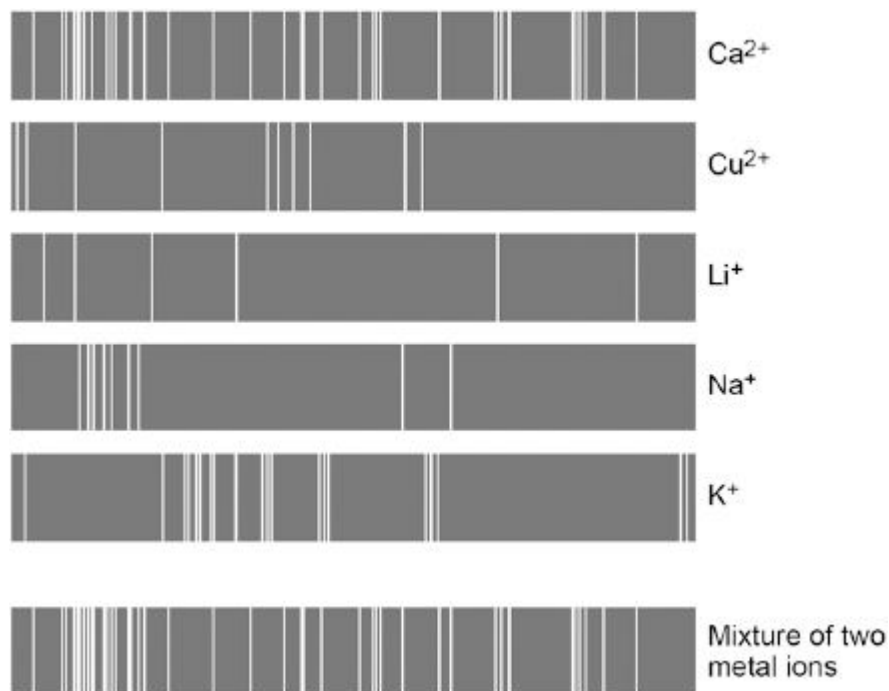
.....

(4)

(e) Flame emission spectroscopy can be used to analyse metal ions in solution.

Figure 3 gives the flame emission spectra of five metal ions, and of a mixture of two metal ions.

Figure 3



Use the spectra to identify the **two** metal ions in the mixture.

.....

.....

(2)

(f) Explain why a flame test could **not** be used to identify the two metal ions in the mixture.

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(2)

(g) Two students tested a green compound **X**.
The students added water to compound **X**.
Compound **X** did not dissolve.

The students then added a solution of ethanoic acid to compound **X**.
A gas was produced which turned limewater milky.

Student **A** concluded that compound **X** was sodium carbonate.
Student **B** concluded that compound **X** was copper chloride.

Which student, if any, was correct?

Explain your reasoning.

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(4)

(Total 18 marks)

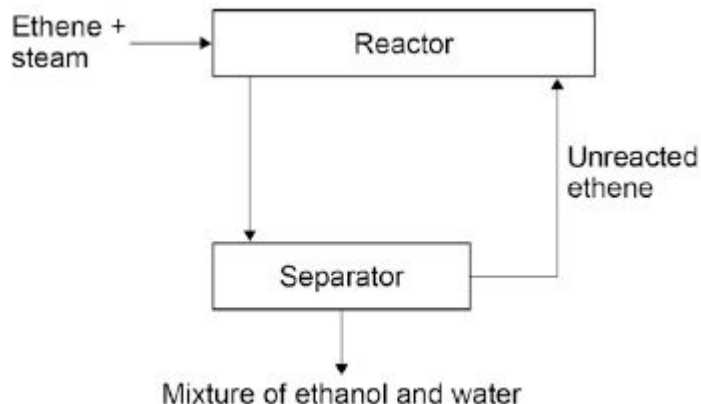
5

In industry ethanol is produced by the reaction of ethene and steam at 300°C and 60 atmospheres pressure using a catalyst.

The equation for the reaction is:



The figure below shows a flow diagram of the process.



- (a) Why does the mixture from the separator contain ethanol and water?

.....

(1)

- (b) The forward reaction is exothermic.

Use Le Chatelier's Principle to predict the effect of increasing temperature on the amount of ethanol produced at equilibrium.

Give a reason for your prediction.

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(2)

- (c) Explain how increasing the pressure of the reactants will affect the amount of ethanol produced at equilibrium.

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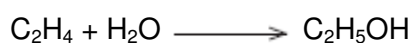
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(2)
(Total 5 marks)

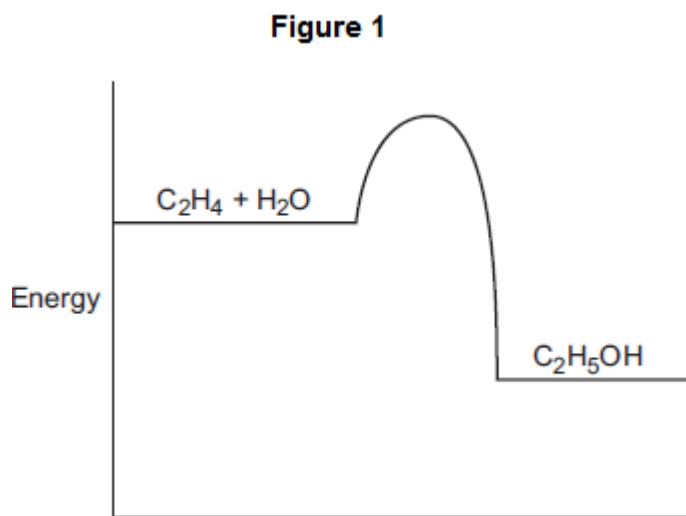
6

This question is about ethanol.

- (a) Ethanol is produced by the reaction of ethene and steam:



- (i) **Figure 1** shows the energy level diagram for the reaction.



How does the energy level diagram show that the reaction is exothermic?

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(1)

- (ii) A catalyst is used for the reaction.

Explain how a catalyst increases the rate of the reaction.

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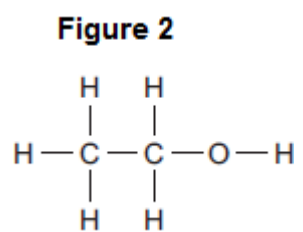
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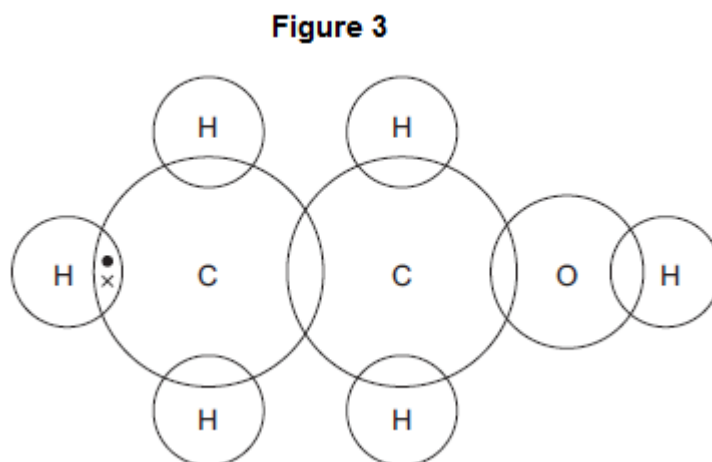
(2)

(b) **Figure 2** shows the displayed structure of ethanol.



Complete the dot and cross diagram in **Figure 3** to show the bonding in ethanol.

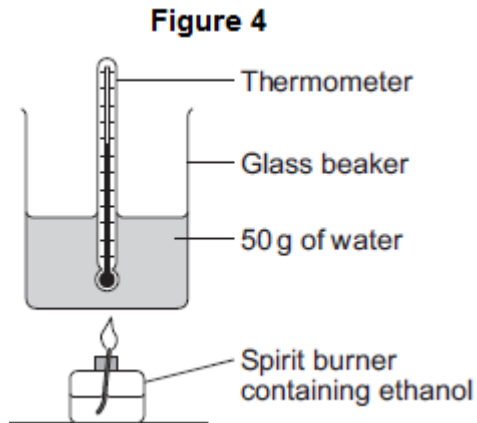
Show the outer shell electrons only.



(2)

(c) A student burned some ethanol.

Figure 4 shows the apparatus the student used.



(i) The student recorded the temperature of the water before and after heating.
His results are shown in **Table 1**.

Table 1

Temperature before heating	20.7 °C
Temperature after heating	35.1 °C

Calculate the energy used to heat the water.

Use the equation $Q = m \times c \times \Delta T$

The specific heat capacity of water = 4.2 J / g / °C

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Energy used = J

(3)

- (ii) **Table 2** shows the mass of the spirit burner before the ethanol was burned and after the ethanol was burned.

Table 2

Mass of spirit burner before ethanol was burned	72.80 g
Mass of spirit burner after ethanol was burned	72.10 g

Calculate the number of moles of ethanol (C_2H_5OH) that were burned.

Relative atomic masses (A_r): H = 1; C = 12; O = 16

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Number of moles burned =

(3)

- (iii) Calculate the energy released in joules per mole.

You should assume that all the energy from the ethanol burning was used to heat the water.

.....

Energy = J / mole

(1)

- (d) The names, structures and boiling points of ethanol and two other alcohols are shown in

Table 3.**Table 3**

Name	Methanol	Ethanol	Propanol
Structure	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{O}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$
Boiling point in °C	65	78	97

Use your knowledge of structure and bonding to suggest why the boiling points increase as the number of carbon atoms increases.

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(3)
(Total 15 marks)

7

This question is about ethanol.

- (a) Ethanol can be made by fermentation of sugars from plants.

- (i) What is a suitable temperature for fermentation?

Draw a ring around the correct answer.

0 °C

25 °C

450 °C

(1)

- (ii) Fermentation produces a dilute solution of ethanol in water.

Name the process used to obtain ethanol from this dilute solution.

.....

(1)

(b) Ethanol made by fermentation can be used as a biofuel.

(i) Explain why increasing the use of biofuels may cause food shortages.

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(2)

(ii) Explain why burning biofuels contributes less to climate change than burning fossil fuels.

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(2)

- (c) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Ethanol can also be made by reacting ethene with steam in the presence of a catalyst.

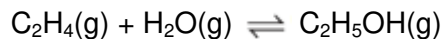


Figure 1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures.

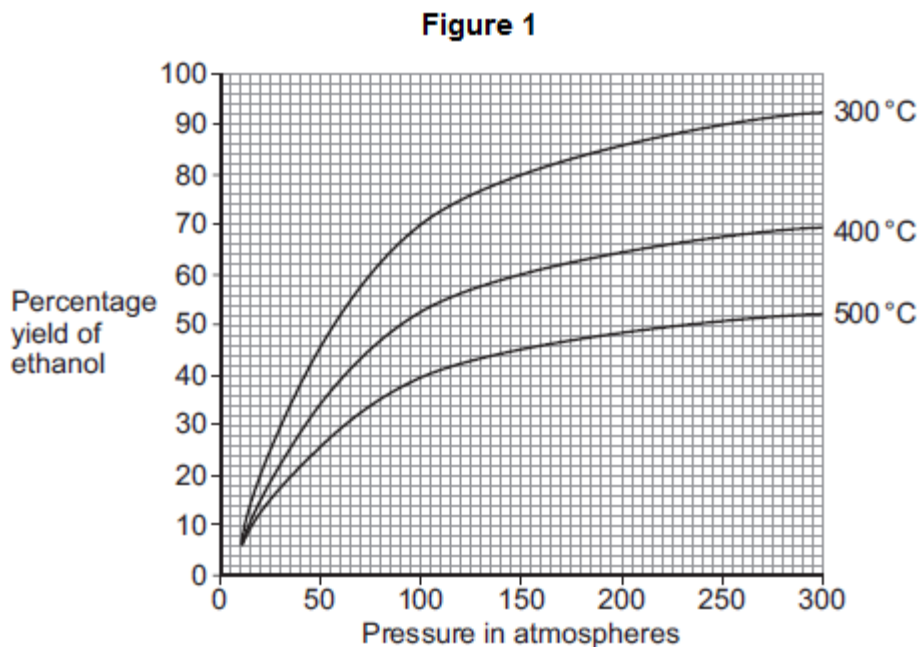
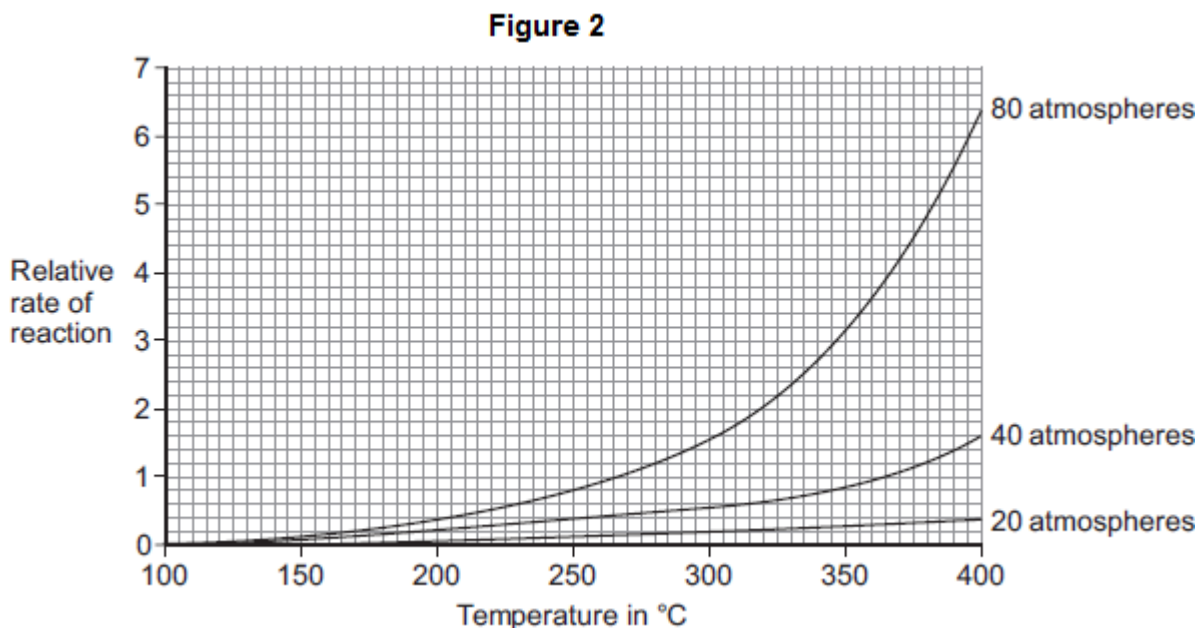


Figure 2 shows how the rate of reaction changes as the temperature changes at three different pressures.



In one process for the reaction of ethene with steam the conditions are:

- 300 °C

- 65 atmospheres
- a catalyst.

Use the information in **Figure 1** and **Figure 2**, and your own knowledge, to justify this choice of conditions.

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(6)
(Total 12 marks)

8

This question is about organic compounds.

- (a) Ethanol burns in air.

Use the correct answer from the box to complete the word equation for the reaction.

carbon	hydrogen	oxygen
--------	----------	--------

ethanol + → carbon dioxide + water

(1)

- (b) Use the correct answer from the box to complete the sentence.

milk	hard water	vinegar
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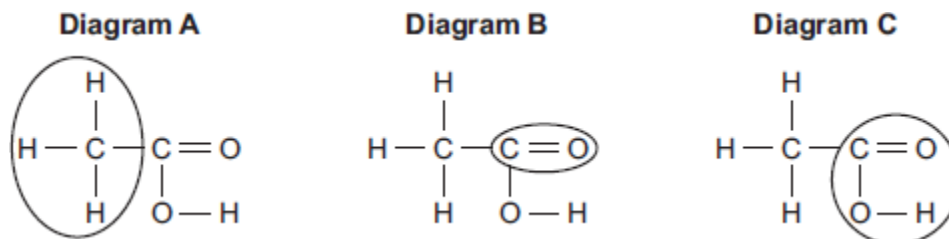
Ethanoic acid is in

(1)

- (c) Ethanoic acid is a carboxylic acid.

Which diagram, **A**, **B** or **C**, has a ring around the functional group of a carboxylic acid?

Write your answer in the box.



Diagram

(1)

- (d) Ethyl propanoate is produced by reacting ethanol with propanoic acid.

What type of organic compound is ethyl propanoate?

Tick (✓) **one** box.

Alcohol

Carboxylic acid

Ester

(1)

- (e) Organic compounds such as ethyl propanoate are used in perfumes.

Give **two** properties of these compounds that make them suitable for use in perfumes.

.....

.....

(2)

(Total 6 marks)

9

This question is about organic compounds.

- (a) Ethanol is an alcohol.
One use of ethanol is in alcoholic drinks.

Give **two** other uses of ethanol.

.....
.....

(2)

- (b) Which gas is produced when sodium reacts with ethanol?

Tick (✓) **one** box.

Carbon dioxide

Carbon monoxide

Hydrogen

Oxygen

(1)

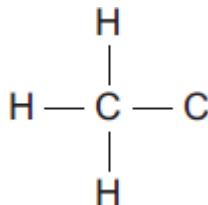
(c) Ethanoic acid (CH_3COOH) can be produced from ethanol ($\text{CH}_3\text{CH}_2\text{OH}$).

(i) What type of reaction produces ethanoic acid from ethanol?

.....

(1)

(ii) Complete the displayed structure of ethanoic acid.



(1)

(iii) Solutions of ethanoic acid and hydrochloric acid with the same concentration have different pH values.

Explain why the solution of ethanoic acid has a higher pH than the solution of hydrochloric acid.

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.....

(2)

(d) Ethanol and ethanoic acid react in the presence of a catalyst to form an ester.

(i) Name the ester made from ethanol and ethanoic acid.

.....

(1)

(ii) What type of chemical is used as a catalyst in this reaction?

.....

(1)

(iii) Esters are used in perfumes because they smell pleasant and are volatile.

What does volatile mean?

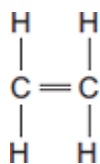
.....

(1)

(Total 10 marks)

10

A molecule of ethene (C_2H_4) is represented as:



- (a) A sample of ethene is shaken with bromine water.

Complete the sentence.

The bromine water turns from orange to

(1)

- (b) Most ethene is produced by the process of cracking.

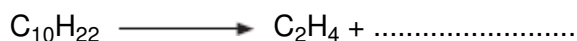
- (i) Complete the sentence.

Cracking is a type of thermal

(1)

- (ii) Decane ($C_{10}H_{22}$) can be cracked to produce ethene (C_2H_4) and **one** other product.

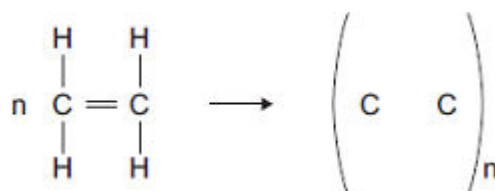
Complete the equation to show the formula of the other product.



(1)

- (c) Many molecules of ethene join together to produce poly(ethene).

- (i) Complete the structure of the polymer in the equation.



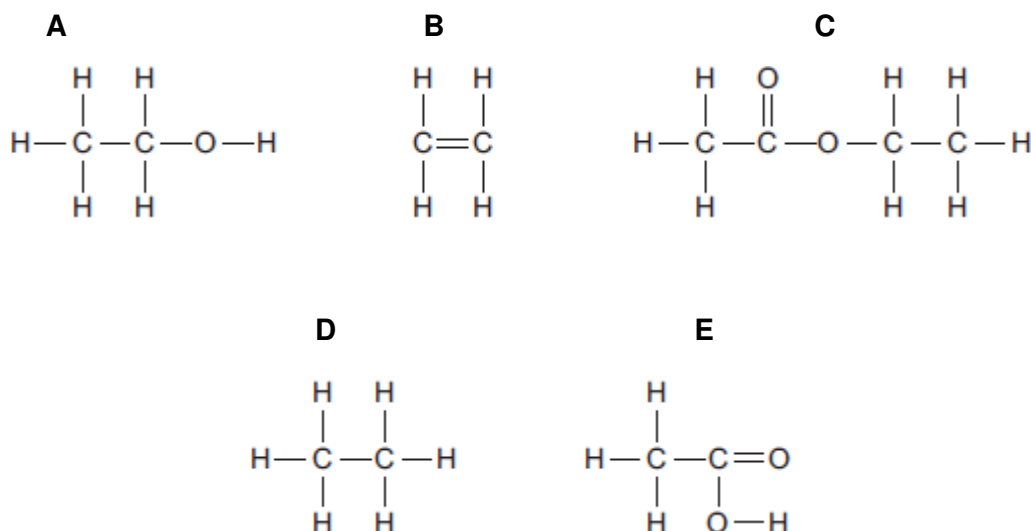
(2)

- (ii) Some carrier bags are made from poly(ethene). Some carrier bags are made from cornstarch.

Suggest **two** benefits of using cornstarch instead of poly(ethene) to make carrier bags.

.....

(2)
 (Total 7 marks)



- (a) Choose which organic compound, **A**, **B**, **C**, **D** or **E**, matches the descriptions.

You may choose each compound once, more than once or not at all.

Write the letter of the compound that:

- (i) is a saturated hydrocarbon

(1)

- (ii) comes from a homologous series with the general formula C_nH_{2n}

(1)

- (iii) has the empirical formula C_2H_6O

(1)

- (iv) reacts with calcium carbonate to produce carbon dioxide

(1)

- (v) reacts with compound **A** to produce compound **C**.

(1)

- (b) Compound **B** (C_2H_4) and C_8H_{18} are produced by cracking $C_{14}H_{30}$



- (i) Give **two** conditions for cracking.

.....

(2)

- (ii) Explain why C_8H_{18} has a lower boiling point than $C_{14}H_{30}$

.....

(2)

- (c) Compound **B** is a colourless gas.

Give a chemical test and its result to show that compound **B** is unsaturated.

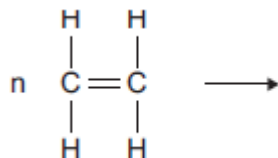
Test

Result

(2)

- (d) Compound **B** is ethene.

Complete the equation to show the formation of poly(ethene) from ethene.



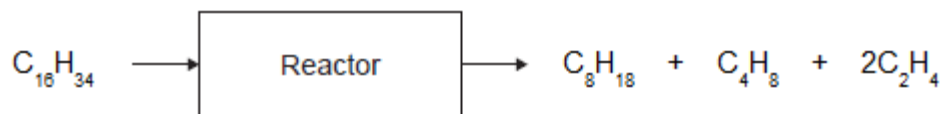
(3)

(Total 14 marks)

12

Poly(butene) is a polymer made from crude oil in two stages.

- (a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown in the figure below.



- (i) The products contain two types of hydrocarbon with different general formulae.

Name the two types of hydrocarbon.

.....

(1)

- (ii) Describe the conditions in the reactor.

.....

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.....

.....

(2)

- (iii) Suggest why air must **not** enter the reactor.

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.....

(1)

- (iv) Suggest a method that can be used to separate butene (C_4H_8) from the other hydrocarbons.

.....

(1)

- (b) The second stage is to use butene (C_4H_8) to produce poly(butene).

- (i) Draw the displayed structure of a butene (C_4H_8) molecule.

(1)

- (ii) Describe how molecules of butene (
- C_4H_8
-) form poly(butene).

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(2)
(Total 8 marks)**13**

This question is about compounds produced from crude oil.

The table below shows four of these compounds.

Compound	Melting point in °C	Boiling point in °C
methane (CH_4)	-183	-164
ethene (C_2H_4)	-169	-104
decane ($C_{10}H_{22}$)	-30	+174
icosane ($C_{20}H_{42}$)	+37	+343

- (a) Tick (✓)
- two**
- correct statements about the four compounds.

Statement	Tick (✓)
Methane has the lowest melting point and icosane has the highest boiling point.	
Ethene and methane are alkanes.	
Methane and decane are gases at room temperature (20°C).	
Decane and icosane are liquid at 100°C.	

(2)

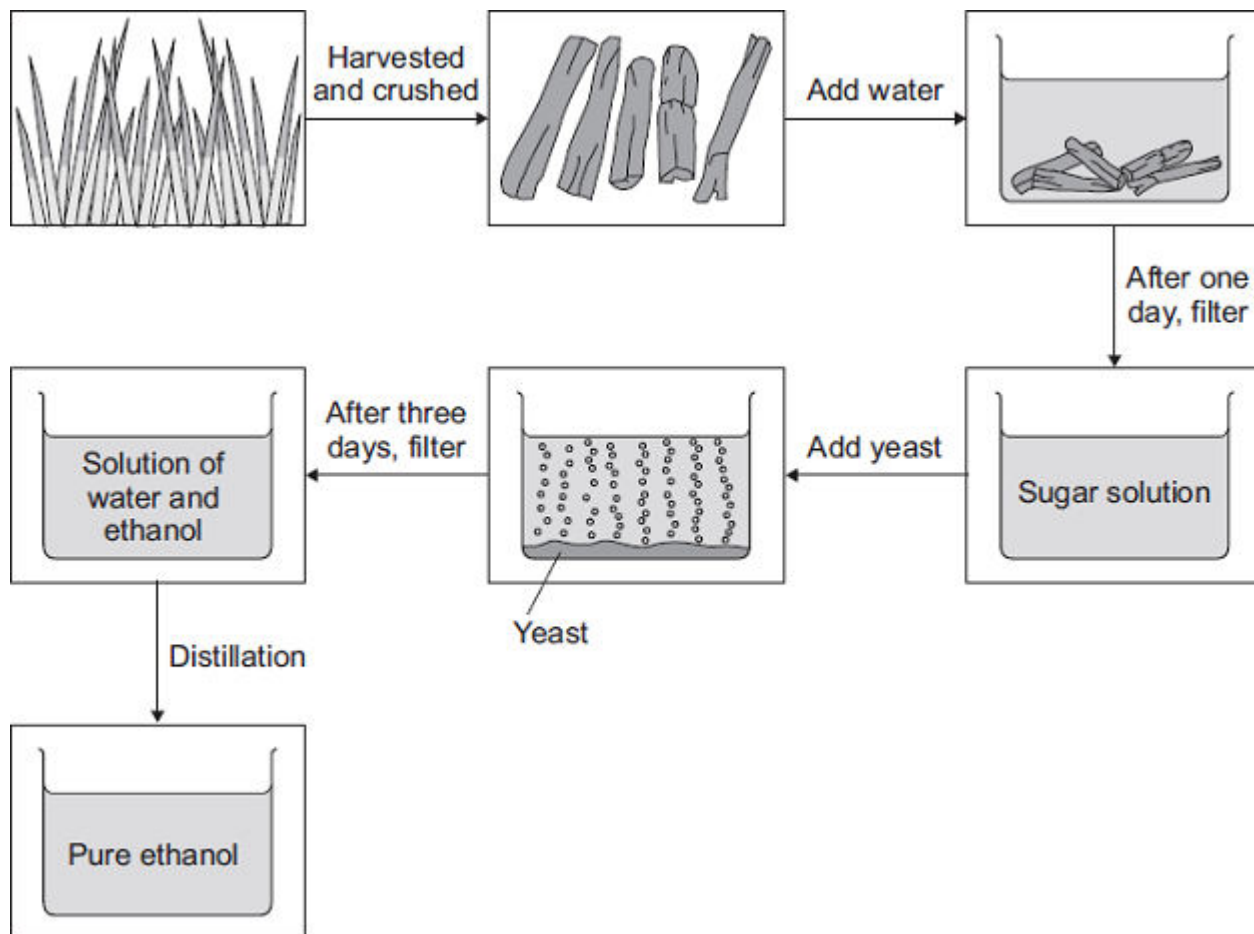
- (b) Petrol contains a mixture of compounds, including octane (
- C_8H_{18}
-).

Complete the word equation for the complete combustion of octane.

octane + oxygen → +

(2)

- (c) Most petrol used in cars contains about 5% ethanol (C_2H_5OH).
Ethanol can be produced from sugar cane.



- (i) Draw a ring around the correct answer to complete the sentence.

The reaction to produce ethanol from sugar solution is

combustion.
displacement.
fermentation.

(1)

- (ii) Some people say that increasing the production of ethanol from sugar cane will be **good** for the environment.

Suggest **two** reasons why.

1

.....

.....

2

.....

.....

(2)

- (iii) Other people say that increasing the production of ethanol from sugar cane will be **bad** for the environment.

Suggest **two** reasons why.

1

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2

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(2)

(Total 9 marks)

14

Most petrol used in cars contains about 5% ethanol (C₂H₅OH).

- (a) The complete combustion of ethanol produces carbon dioxide and water.

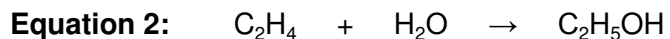
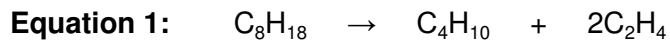
Complete and balance the symbol equation for the complete combustion of ethanol.



(2)

- (b) Ethanol can be produced from octane (C_8H_{18}).

The two chemical equations represent the production of ethanol from octane.



- (i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

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(2)

- (ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

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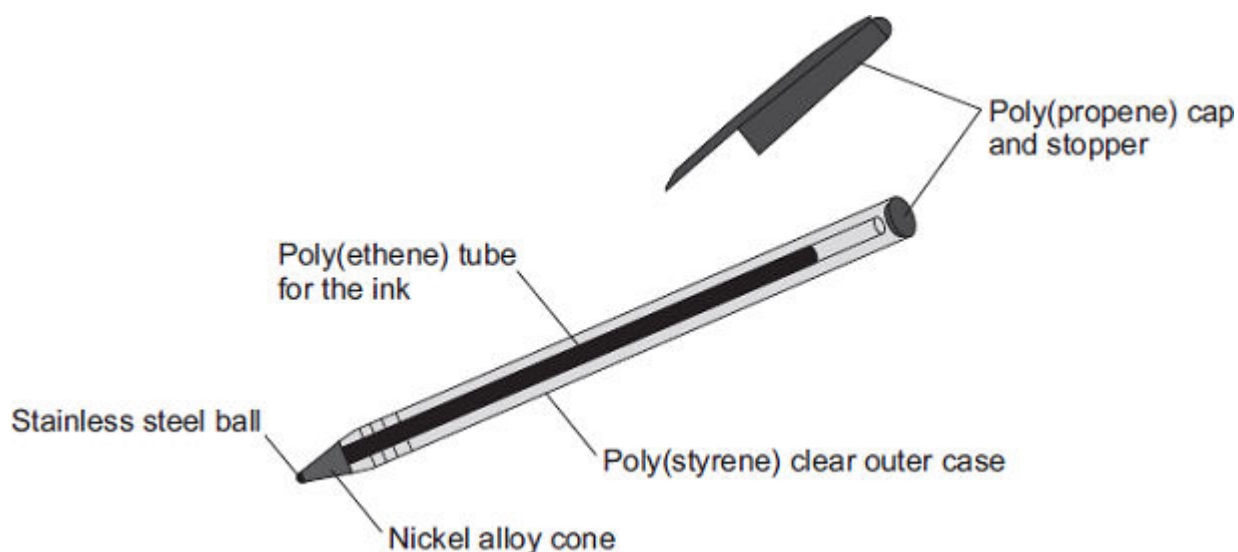
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(4)

(Total 8 marks)

15

The diagram shows a ballpoint pen.



(a) Polymers are used to make the ballpoint pen.

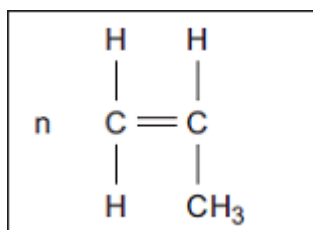
(i) Name the monomer used to make poly(ethene).

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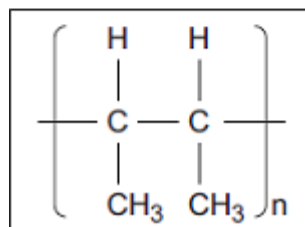
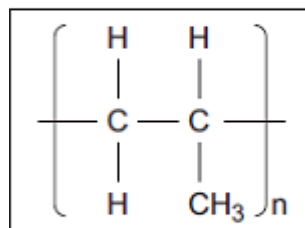
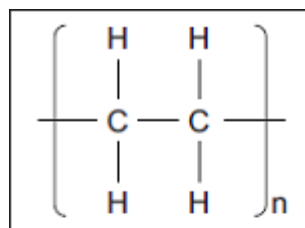
(1)

(ii) Draw **one** line from the monomer propene to its polymer poly(propene).

Monomer

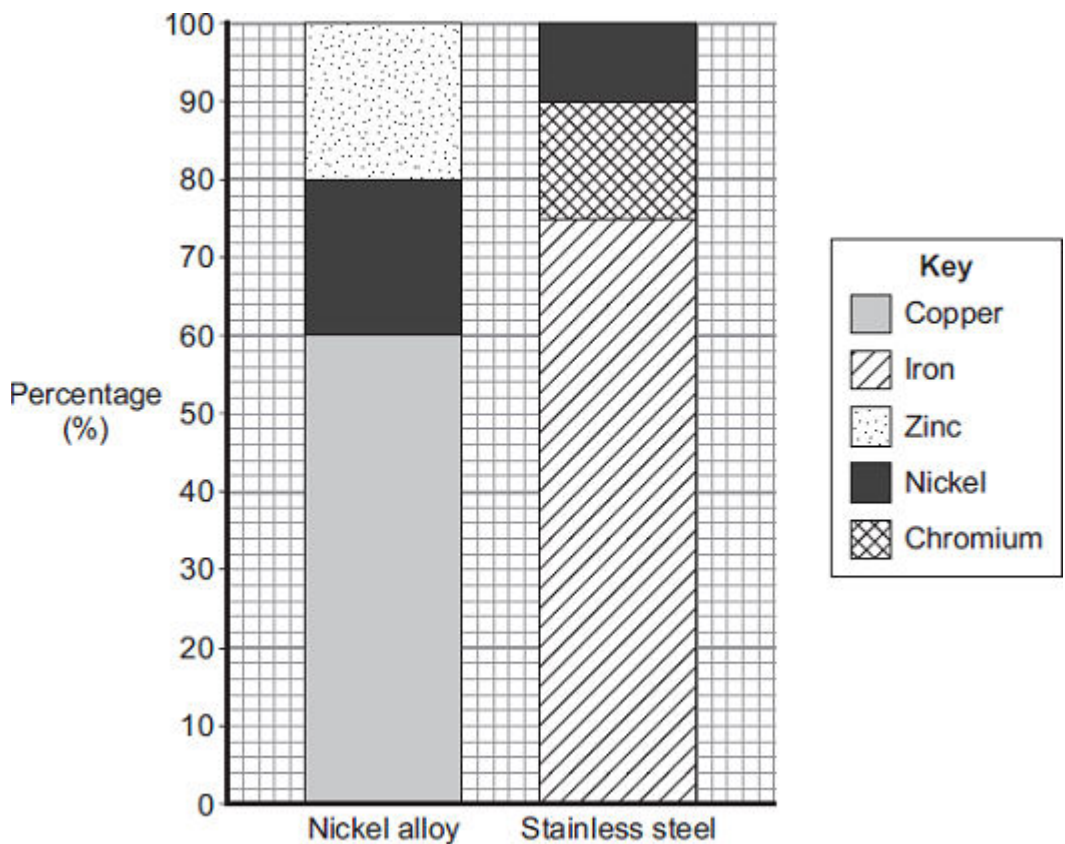


Polymer



(1)

(b) Two alloys are used to make the ballpoint pen.



Use the bar chart to answer these questions.

(i) Which metal is in both of these alloys? (1)

(ii) What is the percentage of iron in the stainless steel? % (1)

(iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.

Give **two** reasons why.

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(2)

- (c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

	Advantage Tick (✓)	Disadvantage Tick (✓)
Can be refilled and reused		
Conserves resources of crude oil and ores		
High cost of separating materials		
Polymers and alloys are not expensive		

(2)
(Total 8 marks)

16

There has been research into fuels for car engines.

Fuel	Content	Melting point in °C	Flashpoint in °C	Energy released in MJ per litre
Ethanol	C ₂ H ₅ OH	-114	+14	21.2
Diesel	hydrocarbons	About -24	+64	38.6
Petrol	hydrocarbons	About -57	-45	34.8
Rapeseed oil	fats	About +5	+130	32.8

The flashpoint is the lowest temperature a fuel vapour ignites in air.

- (a) The melting point of ethanol is precise but the other melting points are approximate.

Suggest why.

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(2)

(b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

(i) Describe how the process of fermentation is done.

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(2)

(ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

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(2)

(c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

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(2)

- (d) Evaluate replacing petrol with ethanol as a fuel for cars.

To gain full marks you should give a justified conclusion.

Use the information from the table and your knowledge to answer this question.

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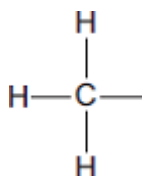
(4)
(Total 12 marks)

17

This question is about organic compounds.

- (a) Wine contains ethanol ($\text{CH}_3\text{CH}_2\text{OH}$).

- (i) Complete the displayed structure of ethanol.



(1)

- (ii) Wine left in a glass for several days turns sour.
The sour taste is caused by ethanoic acid.



Complete the sentences.

The ethanoic acid is produced from a reaction between ethanol
and

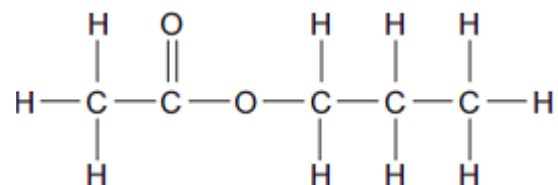
This type of reaction is

(2)

- (b) Propyl ethanoate, a fragrance, can be produced by reacting ethanoic acid with an alcohol.

Propyl ethanoate is a member of a series of organic compounds. The members of the series all have the same functional group.

The displayed structure of propyl ethanoate is:



- (i) Draw a ring around the functional group for this series on the displayed structure of propyl ethanoate.

(1)

- (ii) Name the series of organic compounds with this functional group.

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(1)

- (iii) The alcohol used to make propyl ethanoate has the formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

Name this alcohol.

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(1)

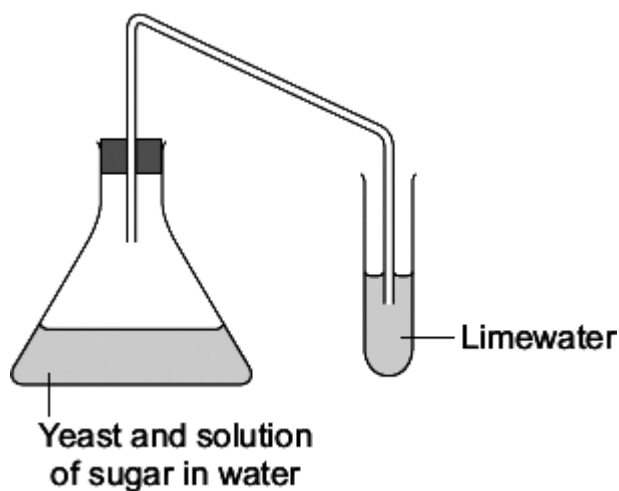
(Total 6 marks)

18

Two fuels that can be used for cars are:

- petrol from crude oil
- ethanol made from sugar in plants.

- (a) A student used the apparatus shown to investigate the reaction to make ethanol from sugar.



- (i) Draw a ring around the correct answer to complete the sentence

This reaction to make ethanol from sugar is

combustion. decomposition. fermentation.
--

(1)

- (ii) Complete the sentences.

The limewater turns

This happens because

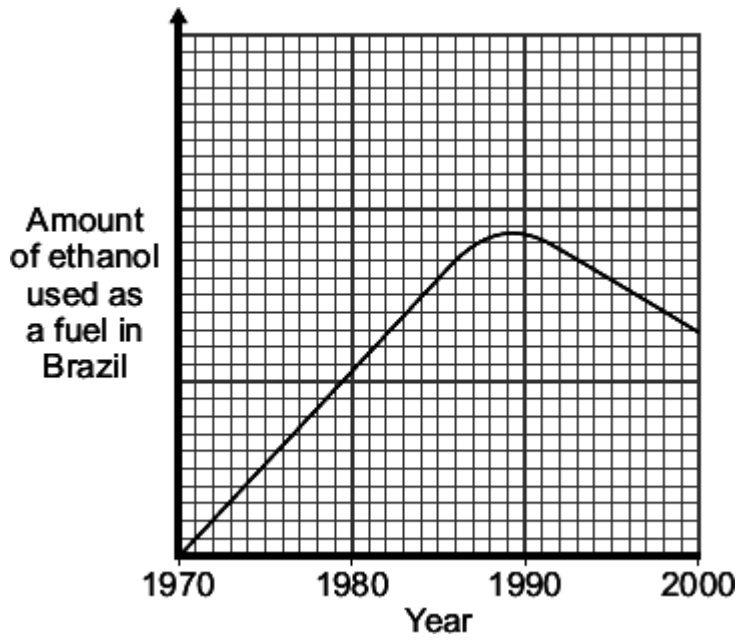
(2)

- (b) In 1970, the Brazilian Government stated that all petrol must contain more than 25% ethanol.

The reasons for this statement in 1970 were:

- Brazil did not have many oilfields
- Brazil has a climate suitable for growing sugar cane.

The graph shows the amount of ethanol used as a fuel in Brazil from 1970 to 2000.



- (i) Use the graph to describe the changes in the amount of ethanol used as a fuel in Brazil from 1970 to 2000.

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(2)

- (ii) In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%.

Suggest **one** reason for their decision.

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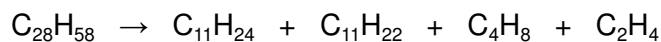
(1)

(Total 6 marks)

19

Ethene is used as a starting material for the production of many other substances, including ethanol.

- (a) Ethene is produced when hydrocarbons are cracked. To do this hydrocarbons are heated to vaporise them. The vapours are then passed over a hot catalyst. The symbol equation shows the reaction for one hydrocarbon.



- (i) One of the products is a different type of hydrocarbon to the other products.

Complete the sentences.

The formula of the product that is a different type of hydrocarbon is

The chemical structure of this product is different to the other products because

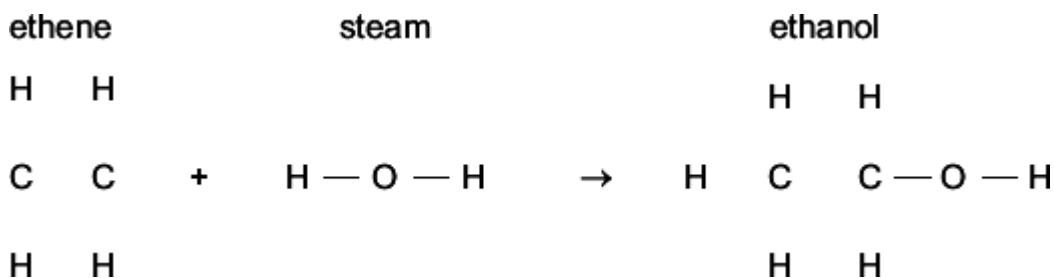
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(2)

- (ii) Ethanol is produced when ethene reacts with steam in the presence of a hot catalyst.

Draw the missing bonds to complete the displayed structures in the equation.



(2)

- (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

In 1970, the Brazilian Government had stated that all petrol must contain more than 25% ethanol. The reasons for this statement in 1970 were:

- the oilfields in Brazil at that time only supplied 20 % of the crude oil needed to make petrol
- Brazil has a climate suitable for growing sugar cane.

To produce ethanol the sugar cane plants are crushed and soaked in water for one day. The sugar solution is separated from the plant material by filtration. Yeast is added to the sugar solution and fermented for three days. The yeast is separated from the solution of water and ethanol by filtration. Ethanol is separated from water by fractional distillation.

In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%. The reasons were that in 2011:

- the demand for ethanol and the price of ethanol had greatly increased
- very large offshore oilfields had been discovered. These offshore oilfields would make Brazil one of the biggest crude oil producers in the world.

Use the information above and your own knowledge and understanding to evaluate whether Brazil should in future produce ethanol from crude oil or produce ethanol from sugar cane.

You should include environmental and economic or social factors in your evaluation.

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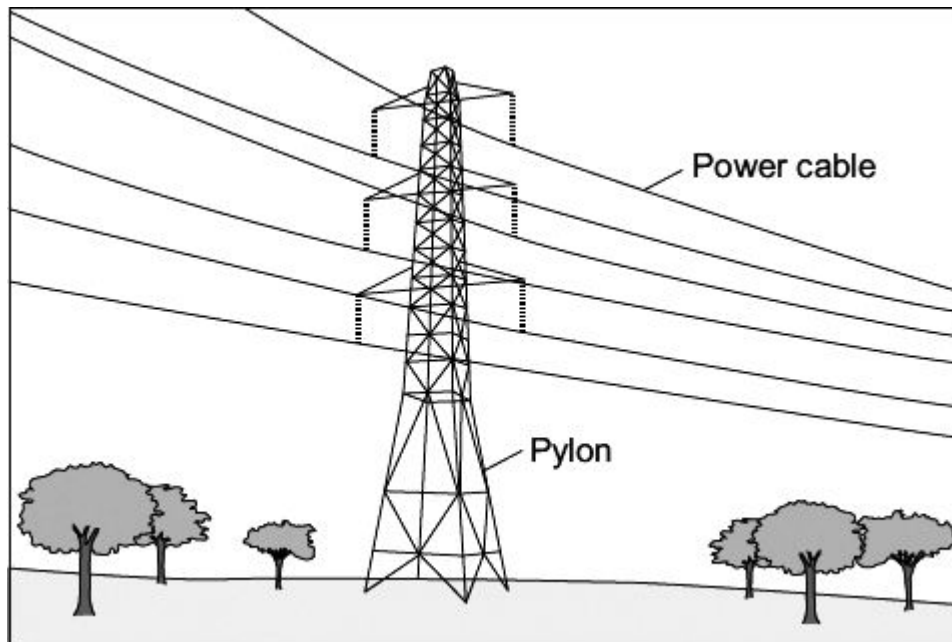
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(6)
(Total 10 marks)

20

Metals are used in the manufacture of pylons and overhead power cables.



(a) Suggest **one** reason why iron (steel) is used to make pylons.

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(1)

(b) The table shows some of the properties of two metals.

Metal	Density in g per cm ³	Melting point in °C	Percentage(%) relative electrical conductivity	Percentage(%) abundance in Earth's crust
copper	8.92	1083	100	0.007
aluminium	2.70	660	60	8.1

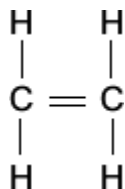
Use the information in the table to suggest why aluminium and **not** copper is used to conduct electricity in overhead power cables.

.....

(2)

- (c) A polymer can be used to cover and insulate power cables.

The polymer is made from the alkene:



Draw a ring around the correct answer to complete each of the sentences.

- (i) The chemical formula of this alkene is

CH

CH₄

C₂H₄

(1)

- (ii) The two lines between the carbon atoms are called a

double bond.

nucleus.

single bond.

(1)

- (iii) The name of the polymer formed when many of these alkene molecules join together

poly(ethene).

is

poly(ethenol).

poly(propene).

(1)

(Total 6 marks)

21

Ethanol (C_2H_5OH) can be made from ethene or from sugar.

- (a) Complete the table which shows the number of atoms of each element in the formula of ethanol.

Use the Chemistry Data Sheet to help you to complete the table.

Element	Symbol	Number of atoms in the formula C_2H_5OH
Carbon	C	2
Hydrogen	H
.....	O	1

(2)

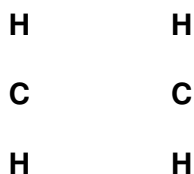
- (b) Ethene (C_2H_4) is produced when hydrocarbons are cracked.

- (i) Tick (✓) **two** conditions needed to crack a hydrocarbon.

Condition	Tick (✓)
The presence of an emulsifier.	
Heating the hydrocarbon to a high temperature.	
Adding oxygen to the hydrocarbon.	
The presence of a catalyst.	

(2)

- (ii) Draw the missing bonds to complete the displayed structure of ethene.



(1)

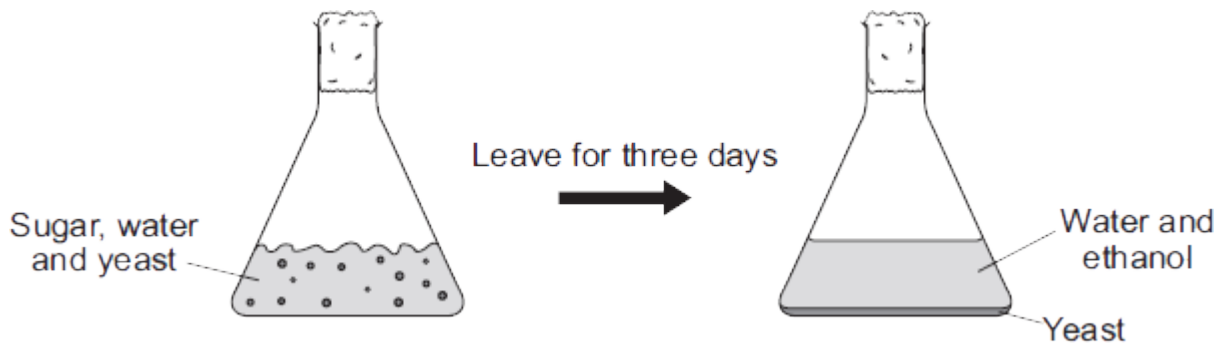
- (iii) Name the substance added to ethene (C_2H_4) to produce ethanol (C_2H_5OH).

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(1)

(c) The diagram shows how a solution of ethanol is made from sugar dissolved in water.

The boiling point of ethanol is 78°C and the boiling point of water is 100°C.



(i) Name the gas produced during this reaction.

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(1)

(ii) What are the main steps needed to obtain pure ethanol from the mixture produced after three days?

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(2)

(Total 9 marks)

22

Ethanol (C₂H₅OH) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

Ethanol from sugar cane is a batch process	Ethanol from crude oil is a continuous process
Sugar cane plants are crushed and soaked in water for one day.	Crude oil is distilled to separate the naphtha fraction.
The sugar solution is separated by filtration.	The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst.
Yeast is added to the sugar solution and fermented for three days.	The ethene produced is separated by distillation.
The solution of water and ethanol produced is separated by filtration.	Ethene is reacted with steam in the presence of a catalyst.
Distillation of this solution produces a 50% solution of ethanol.	This hydration reaction produces 100% ethanol.

- (a) Complete and balance an equation for the cracking of the hydrocarbon C₆H₁₄ to produce ethene.



(2)

- (b) What is **seen** when the sugar solution and yeast are fermented?

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(1)

- (c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.

You should explain why each issue you describe is important.

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(5)
(Total 8 marks)

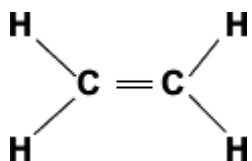
23

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers.

Plastic bags are made from a polymer.

The polymer is made from ethene.

The structural formula of ethene is shown.



Ethene is made by cracking hydrocarbons.

These hydrocarbons come from crude oil.

(a) Complete these sentences about ethene.

(i) Ethene is a hydrocarbon because it contains only and

.....

(2)

(ii) Ethene is unsaturated because it has a bond.

(1)

(b) Tick (✓) the name of the polymer formed when many ethene molecules join together.

Name of polymer	Tick (✓)
poly(chloroprene)	
poly(ethene)	
poly(propene)	

(1)

(c) Suggest **two** reasons why supermarkets should stop giving plastic bags to customers.

1

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2

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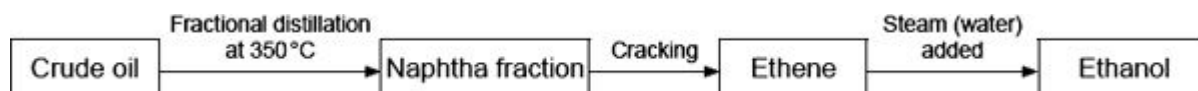
(2)

(Total 6 marks)

24

Petrol sold in most countries now contains at least 5% ethanol. The production of ethanol, for use as a fuel, is being increased.

The flow diagram shows how ethanol can be produced from crude oil.

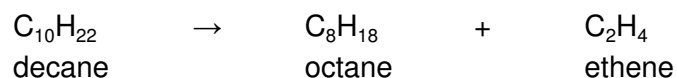


(a) Why does crude oil need to be fractionally distilled?

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(1)

(b) Hydrocarbons, such as decane, in the naphtha fraction are cracked to produce ethene. The balanced chemical equation shows the cracking of decane.

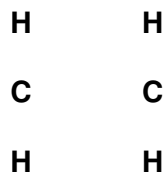


(i) Describe how cracking is done.

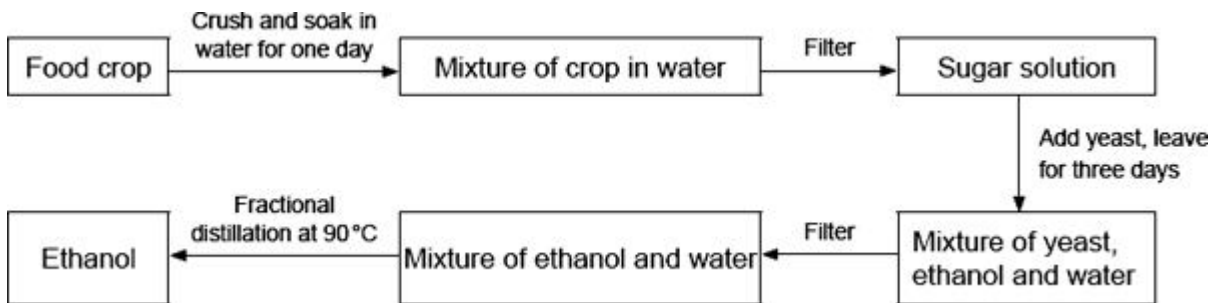
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(2)

(ii) Complete the structural formula of ethene by drawing lines to represent each covalent bond.

**(1)**

(c) The flow diagram below shows how ethanol, for use as a fuel, can also be produced from food crops.



Use the information in the two flow diagrams and your own knowledge and understanding to evaluate whether more of this ethanol should be produced from food crops or from crude oil.

Remember to give a conclusion to your evaluation.

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(5)
(Total 9 marks)

25

Chlorine and bromine are important Group 7 elements.

- (a) Explain why chlorine is added to drinking water.

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(1)

- (b) Describe what you would **see** when bromine water is added to an unsaturated organic compound.

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(1)

- (c) Bromine can be extracted from seawater. The dissolved bromide ions are reacted with chlorine. Bromine and chloride ions are formed.

- (i) Complete and balance the equation below, which represents the reaction between chlorine and bromide ions.



(1)

- (ii) Describe what you **see** when chlorine is added to a solution containing bromide ions.

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(1)

- (d) In terms of electronic structure:

- (i) state why bromine and chlorine are both in Group 7

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(1)

(ii) explain why bromine is less reactive than chlorine.

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(3)

(e) What is the result of adding acidified silver nitrate solution to a solution containing:

(i) chloride ions

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(1)

(ii) bromide ions?

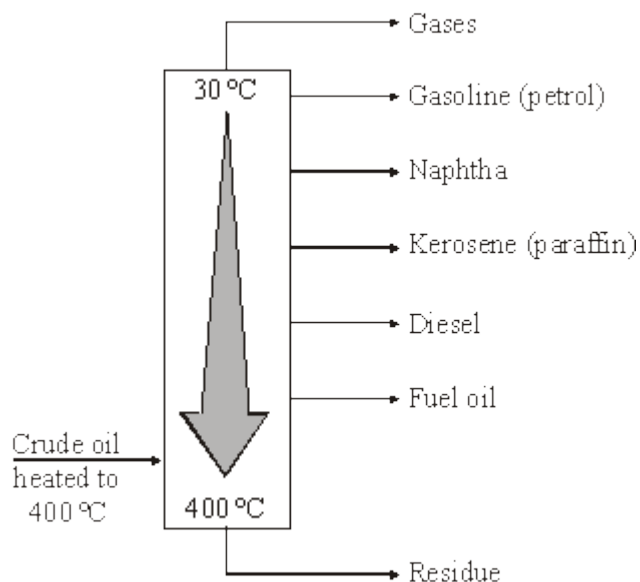
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(1)

(Total 10 marks)

26

Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



- (a) Describe how the naphtha fraction separates from the other fractions.

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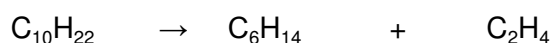
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(2)

- (b) The naphtha fraction is often used to make other useful materials.

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:



- (i) Balance the symbol equation given above.

(1)

- (ii) Describe how cracking is carried out.

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(2)

(iii) Why does ethene have different chemical properties from decane and hexane?

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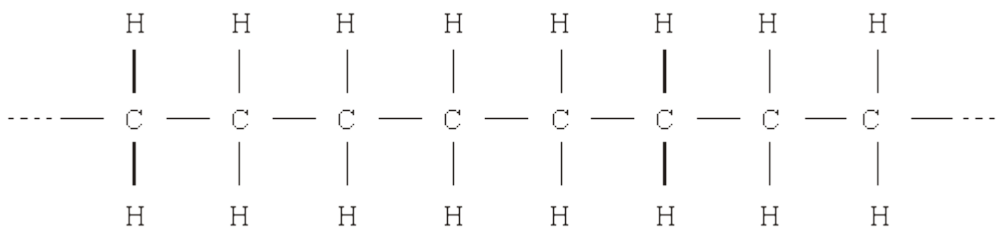
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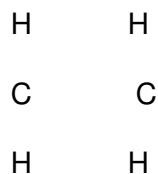
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(2)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.



(1)

(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?

(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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(4)
(Total 12 marks)

27

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

- (a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmospheres of Mars and Earth as they are now.

Mars		Earth	
nitrogen	3%	nitrogen	78%
oxygen	trace	oxygen	21%
water	trace	water	trace
carbon dioxide	95%	carbon dioxide	trace
Average surface temperature $-23\text{ }^{\circ}\text{C}$		Average surface temperature $15\text{ }^{\circ}\text{C}$	

Suggest what has caused the main gases in the Earth's atmosphere of millions of years ago to change to the present-day atmosphere.

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(2)

- (b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth's, contains mainly nitrogen. Methane is the other main gas.

Main gases in Titan's atmosphere	Percentage (%)	Boiling point in $^{\circ}\text{C}$
Nitrogen	95	-196
Methane	5	-164
Average surface temperature $-178\text{ }^{\circ}\text{C}$		

When it rains on Titan, it rains methane! Explain why.

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(2)

(c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene and propene, from methane in Titan's atmosphere.

(i) Draw the structure of propene, C_3H_6 , to show the covalent bonds.

(1)

(ii) Explain how propene molecules form a polymer. You should name the polymer formed.

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(3)

(Total 8 marks)

28

Known crude oil reserves are being used up rapidly. Crude oil is used to produce many useful fuels, such as petrol. One way to conserve crude oil reserves would be to increase the production of bio-fuels.

(a) Ethanol can be produced for use as a bio-fuel. Cars can be powered by ethanol or ethanol-petrol mixtures.

Sugar cane can be fermented to give a mixture of water (boiling point $100\text{ }^{\circ}\text{C}$) and ethanol (boiling point $78\text{ }^{\circ}\text{C}$).

(i) How can ethanol be separated from water?

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(1)

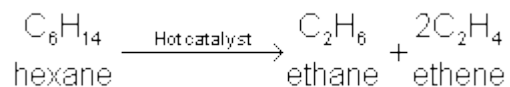
- (ii) Ethanol, C_2H_5OH , burns to release heat energy.

Complete the balanced symbol equation by writing in the formulae of the two products.



(2)

- (b) The cost of producing a bio-fuel, such as ethanol, by fermentation, is at least three times higher than the production cost of petrol. It costs less to produce ethanol from alkanes. In the production, the vapour of an alkane is passed over a hot catalyst.



Ethene is then converted into ethanol.

- (i) What has happened to the hexane to produce ethene?

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(1)

- (ii) Complete the structural formula for ethene, C_2H_4 .

C C

(1)

- (iii) Name the compound that is added to ethene to produce ethanol, C_2H_5OH .

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(1)

- (c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

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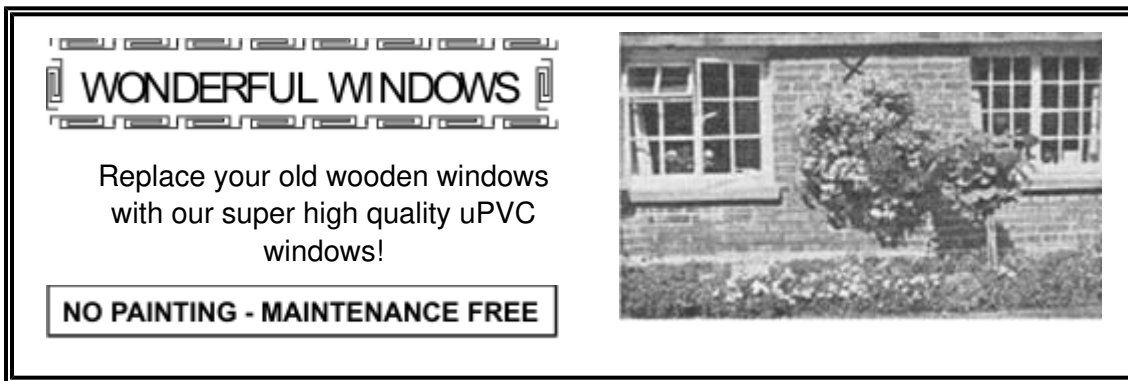
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(4)
(Total 10 marks)

29

Modern window frames are often made from uPVC which contains the plastic poly(chloroethene).



- (a) State why plastic window frames need no painting or maintenance.

.....

.....

(1)

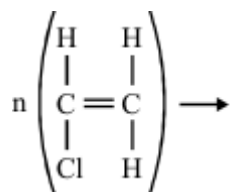
(b) Poly(chloroethene) is a polymer formed by the *addition polymerisation* of chloroethene.

- (i) Chloroethene is an unsaturated molecule. Why is this molecule said to be unsaturated?

.....

(1)

- (ii) Complete the diagram to represent how poly(chloroethene) is formed from chloroethene.



(3)

- (iii) Explain what is meant by the term *polymerisation*.

.....

(2)

- (iv) Why is this an *addition polymerisation*?

.....

(1)

(Total 8 marks)**30**

- (a) Alkenes can be made by cracking large alkane molecules.

- (i) Explain how the cracking process is carried out.

.....

(2)

- (ii) Give a chemical test which would show the difference between an alkene and an alkane.

Test

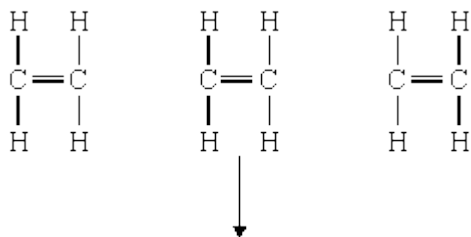
Result of test

.....

(2)

- (b) Alkenes, such as ethene, can be made into polymers.

- (i) Complete the following to show how the ethene molecules bond to form part of a polymer.



(1)

- (ii) Name the polymer formed from ethene.

.....

(1)

- (iii) Explain **one** important problem caused by the everyday use of this polymer.

.....

.....

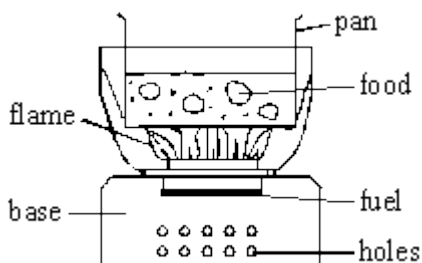
.....

(2)

(Total 8 marks)

31

The diagram below shows a camping stove used by some students.



A student wrote the report below to explain how the stove works. The report has had some words removed. Complete the report using words from the list.

air	chemical change	liquids	physical change
argon	gases	nitrogen	solid
carbon dioxide	heat energy	oxygen	water vapour

To use the stove a fuel called methylated spirits is poured into the burner and lit with a match.

The holes in the base let into the stove. This contains the gas called which is needed for the fuel to burn.

When the fuel burns, new substances are formed. This shows that a takes place.

When all of the methylated spirits has burned nothing is left in the burner. This shows that the new substances must all be

Methylated spirits contains carbon and hydrogen. When the fuel burns the carbon is changed into

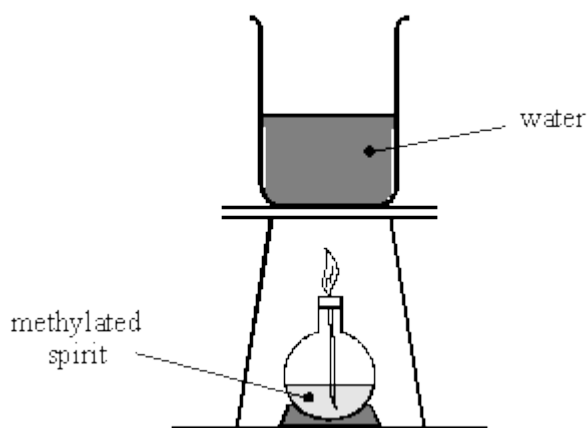
The hydrogen is changed into

When the fuel burns it gives out which cooks the food in the pan.

(Total 7 marks)

32

A student is using a spirit burner to heat some water.



- (a) Complete these sentences.

Substances like methylated spirit which we burn to give out energy, are called
 The energy is given out as energy.

(2)

- (b) Choose a word from this list to complete the sentence below.

gases liquids solids

The methylated spirit seems to disappear as it burns.

The new substances produced during burning are mainly

(1)

(Total 3 marks)